International Journal of Future Generation Communication and Networking
Vol. 13, No. 4, (2020), pp. 4417–4439

Analysis of Machine Learning (Ml) and Deep Learning (Dl) Methods for Predicting Students' Performance

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ABSTRACT: Predicting students' performance is major important areas for education backgrounds which includes of schools and universities because it helps develop effective methods with the purpose of increasing academic results and evading dropout, among other things. Consequently, analyzing and processing this information carefully will be able to provide valuable information regarding the students' understanding and the association among them and the educational tasks. It is able to be used for various purposes; for instance, a strategic plan is able to be useful for the improvement of a value education. It might happen due to two major reasons. Primary, the learning of recent prediction methods is still inadequate to recognize the most appropriate algorithms for predicting the results of students. Second is suitable towards the need to study the factors concerning student's success in exacting courses. This paper we review on Data Mining (DM) techniques for student performance forecast to increase student's achievements. It reviews regarding the information of DM algorithms with respect to Machine Learning (ML) and Deep Learning (DL) methods in order to predict the performance of students depending on their historical information. It also gives a review on the DM techniques towards student's performance prediction. It also focuses on how these algorithms are able to be used to recognize the mainly significant features in a student's data. This review study gives educators an easier access to ML and DL algorithms, enabling each and every one the possibility of their application towards the area of education. This review might bring the benefits and impact to students, educators and educational institutions. Finally it also provides a way to the extension of DL methods for student performance prediction.

Keywords: - Machine Learning (ML), Deep Learning (DL), students' performance, Prediction, and Deep Support Vector Machine (DSVM).

1. INTRODUCTION

Students' academic performance detection is major important field of Educational Data Mining (EDM) [1, 2]. With the development of technology, technical investments in the area of education have improved. Down by means of technical developments, e-Learning platforms and multimedia technologies have been introduced for reducing the learning costs, time and space restrictions [3]. Students' performance prediction estimation becomes a more challenging task since of the huge amount of data in training databases [4]. Descriptive statistical study is able to be successfully used to give the essential descriptive data of a specified set of information [5]. On the other hand, this only is not forever sufficient. To notify the instructors and students early on students might be able to recognize untimely by approximate modeling methods [6]. It is helpful towards categorizing university students

ISSN: 2233-7857 IJFGCN

related towards their possible educational performance in order to improve achievement rates [7].

To develop their teaching skills, the capacity to predict student's performance patterns is very necessary. It is a significant factor that can be utilized for diverse purposes. To illustrate, a key arrangement be able to be introduced for the improvement of quality learning. This is where Data Mining (DM) [8] becomes possibly the most important factor. DM methods examine datasets and extract data to convert it addicted to justifiable formations for afterward utilize. DM is connected to different areas like healthcare [9], business [10], and furthermore in education [11]. As an application of DM, businesses be able to study more regarding their customers and more successful approaches are developed related to a range of business functions and in turn influence resources in a more optimal and perceptive way. It helps to achieve the goals of business and make improved assessment. In reality, the advancement of educational data set administration frameworks made countless education datasets, which empowered the use of data mining to dissociate helpful data from this information. This prompted the development of EDM as a free exploration field [12-13]. These days, EDM plays a noteworthy part in finding examples of information about educational phenomena and the learning cycle [14] together with perceptive performance.

Particularly, DM is being utilized for anticipating an assortment of vital educational results, similar to execution [15], retention, success [16], satisfaction, accomplishment [17], and dropout rate [18]. The cycle of EDM is an iterative information revelation measure that comprises of theory plan, testing, and refinement [19]. Notwithstanding numerous writings, including contextual analyses, on EDM, it is as yet hard for instructors – particularly on the off chance that they are a learner to the field of DM – to viably apply these strategies to their particular academic issues. Each progression portrayed in Figure 1 requires a few choices and set-up of boundaries, which legitimately influence the nature of the acquired outcome.

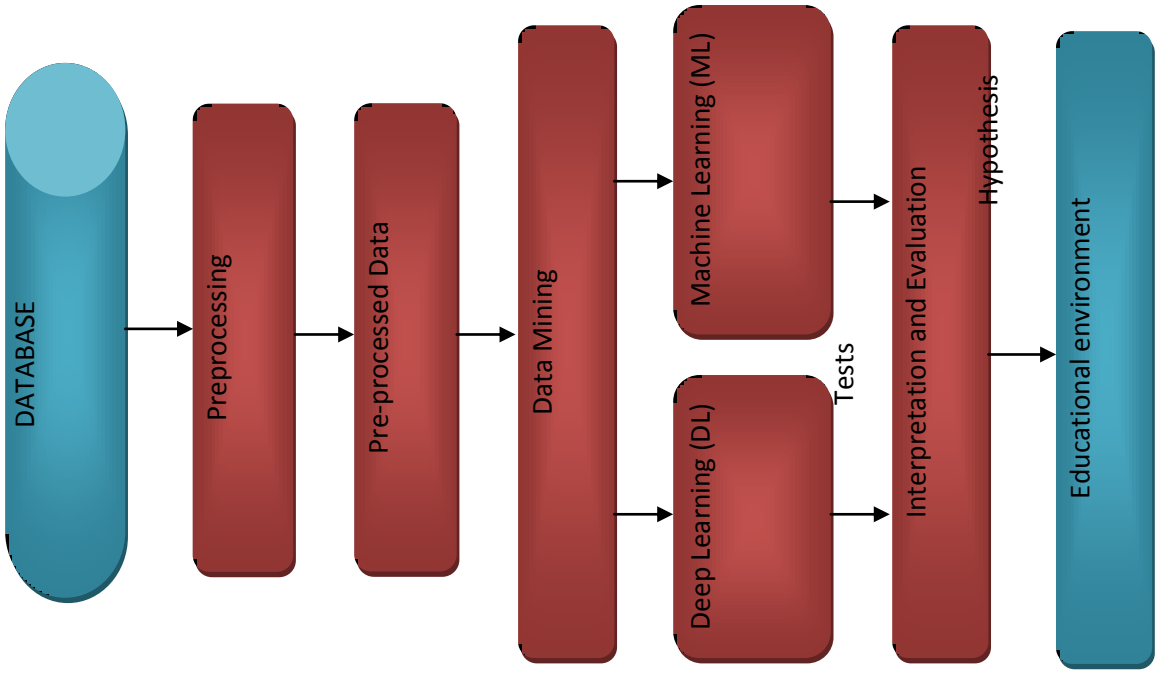

FIGURE 1: - Knowledge Discovery Process in Educational Institutions [19]

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Currently, there is a significant number of study and researches with the purpose of go behind the length of the lines of detecting students' behaviour, between further associated area in the learning field. Certainly, several works have been available in academic journals and existing in symposium on this area. Thus, the major aim of this review is to introduce an in detail summary of the various methods and techniques with the purpose of have been applied to this area. Though student performance forecast have been broadly studied in the following review analysis. Most of the recent works are being able to be categorized into two methods:

The primary conventional method majorly depends on usual methods such as Support Vector Machine (SVM), K-Nearest Neighbor (K-NN), Artificial Neural Network (ANN), Naïve Bayes (NB), Decision Tree (DT), and Logistic Regression (LR), Fuzzy Genetic Algorithm (FGA), Linear Regression (LR), Linear Support Vector Machine (LSVM), Random Forest (RF), Learning Discriminant Analysis (LDA), Classification and Regression Tree (CART) and AdaBoost classifier. Each model regard as diverse category of behavioral and analytical features extracted from a variety of raw activity records (e.g., clickstream, grades, forum, and grades).

The second promising methods include a study of Deep Learning (DL) methods. Some of the works uses following methods such as Deep Neural Network (DNN) model, Bidirectional Long Short Term Memory (BLSTM), Exercise-Enhanced Recurrent Neural Network (EERNN), Exercise-aware Knowledge Tracing (EKT), Recurrent Neural Network (RNN) model and Sequential Prediction based on Deep Network (SPDN). On the other hand, each and every one of these new methods, so far, has exposed primitive results. This is mostly since the methods still rely on feature engineering to decrease input dimensions which appears to restrict one to introduce larger (i.e., better) than conventional methods.

This paper will focus on calculating student performance has been broadly considered in the literature review section by means of above mentioned two methods. The methods like Support Vector Machine (SVM) and DL provides higher performance than the individual DL and ML methods. Thus this review also study about the combined SVM and DL for student performance prediction. Finally concludes the review by means of the DL and ML methods which are used for academic performance prediction.

2. MACHINE LEARNING METHODS FOR STUDENT PERFORMANCE PREDICTION

In recent years, Machine Learning (ML) for education has received a lot of interest. In solving issues or completing classes, a large amount of literature focuses on predicting student success.

Livieris et al[20] formulated an Artificial Neural Network (ANN) to predict the performance of learners. Artificial Intelligence (AI) has allowed more advanced and more effective student models to be developed that reflect and detect a wider spectrum of student activity than was previously possible. "In this work, the implementation of a user-friendly software tool to predict the performance of students in the" Mathematics "course based on a NN classifier is defined. This method has a simple interface and can be used by an instructor to identify students and differentiate students who are likely to have low achievements or poor students with low achievements.

Xu et al [21] developed a Probabilistic Matrix Factorization (PMF) for predicting student performance. The method of machine learning to predict student success in degree

ISSN: 2233-7857 IJFGCN

programmes (1) Students vary immensely with respect to backgrounds and selected courses; (2) Courses are not uniformly insightful to make precise predictions; (3) To overcome these main obstacles, the changing progress of students needs to be integrated into the prediction. There are two main characteristics of the suggested methodology. First, to make predictions based on the changing performance states of students, a bilayered structure are introduced which includes of several base predictors and a cascade of ensemble predictors. Second, a data-driven strategy is introduced to discover course relevance depending on latent factor methods and PMF, which is critical for creating successful base predictors. Simulations are implemented on undergraduate student database from University of California; Los Angeles (UCLA) over three years, the proposed method demonstrates that benchmark approaches achieve superior efficiency. Proposed approaches may be used in combination with other educational methods for assessing the success of students and provide academic advisors with useful information to prescribe following courses to students and, if necessary, do pedagogical involvement steps.

Al-Shehri et al [22] introduced a SVM and K-NN to forecast the academic achievement of students in the final test. By using the standard set of data provided through the University of Minho in Portugal, the work includes of 395 data samples and relates to performance and efficiency in mathematics. In taking early precautions, taking instantaneous measures, or selecting a student who is suited for a certain task, student performance forecasting can be useful. It is not achievable to over emphasize the necessity to produce better outcomes with better models. K-NN was used for most of the previous work on the same dataset and achieved low performance, while SVM was hardly ever used, that is a too frequent with effective prediction strategy. In order to improve good comparison and to predict the ranking of the student and then for comparing their accuracy SVM and K-NN were added to the dataset. The outcome of empirical experiments showed that SVM obtained marginally better results with a coefficient of correlation compared to the coefficient of correlation of K-NN.

Altabrawee et al [23] formulated an ANN, NB, DT, and Logistic Regression (LR) for predicting students' performance. In order to construct a classifier which can determine the output of students who offered computer science by Al-Muthanna University (MU), College of Humanities, and these four algorithms for machine learning were used. This study pays special concentration to the impact of using e-learning resource and effects on student's success in spending time by students on social networks. These results are accomplished by means of features that decide when the student implements e-learning and how much hours the students spend on social media. Using the Receiver Operating Characteristic (ROC) curve index output measure and with the classification accuracy, the algorithms were validated. In addition, various tests like classification error, accuracy, recall, and measure F, have been computed. Basis on the students' survey and the ranking book of the students, the dataset used to create the models is gathered. The best outcomes were achieved by the ANN model and the best classification accuracy was achieved. In addition, the five factors were defined by the DT model as important for affecting the outcomes of the students.

Hamsa et al [24] proposed a DT and Fuzzy Genetic Algorithm (FGA) for student's performance in academic forecast mode. The development of the educational outcomes forecasting model using two chosen classification methods for Bachelor's and Master 's degree students in computer science and electronics and communication: DT and FGA. Internal marks, session marks, and admission score is considered as important parameters for simulation. Internal marks are integrated to attendance marks, average scores are computed

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from two session assessments and assignment marks. For degree learners, the cumulative score is computed from 10^{th} and 12^{th} assessment marks and entrance marks is considered as the admission score. Master's degree candidate's needs degree exam marks and entrance marks. It is possible to use the resultant prediction model to classify the output of the student for each subject. The lecturers are thus able to identify students and take early steps to enhance their efficiency. In order to enhance efficiency over time, systematic methods can be taken. In final examinations, better outcomes can be predicted due to early forecasting and solutions are obtained. Students will access their alerts and academic records. Reputed businesses that have a connection with the organization will look for students as per their requirements.

Oloruntoba and Akinode [25] introduced a SVM for student academic performance prediction. It explores the relationship between the academic profile of pre-admission students and final academic results. Data A student sample was used at one of the Federal Polytechnics in the south-western part of Nigeria. The 'O' level grades (terminal high school results) are the pre-admission academic profile used for this analysis. Academic performance is determined using the Grade Point Average (GPA) of the student. It focuses on creating a model for predicting student success based on 'O' level outcomes and their first 3 semesters of each semester using data mining technique. To eliminate the outcomes of rusticated and expelled students, data preprocessing was performed. Results obtained by contrasting SVM with other ML techniques such as KNN, DT; Linear Regression (LR) suggests that other ML algorithms are outperformed by SVM. The SVM algorithm (kernel) parameters were also optimised to enhance its accuracy and the result obtained shows that the penalty Radial Basis Function (RBF) kernel (C=100) performs best. SVM and RBF had given the highest training accuracy, predicting accuracy that surpasses other state-of-the-art ML techniques such as KNN, DT, etc.

Naicker et al [26] proposed a Linear Support Vector Machine (LSVM) for predicting the student performance. To evaluate the algorithm with the purpose of would improve student success prediction, the LSVM classifier is compared through state-of-the-art conventional machine learning classifiers. For quantitative analysis an experimental research design was used. In an openly accessible dataset of 1000 alpha-numeric record of student, trials were set up with the use of feature selection. Benchmarked with 10 categorical machine learning algorithms, LSVM demonstrated better-quality results in student performance prediction. The findings showed that characteristics such as race, gender, and lunch affect mathematics performance while access to lunch was the primary factor affecting the performance of reading and writing.

Almasri et al [27] developed an Ensemble Meta-based Tree (EMT) classifier for predicting the student performance. Three major steps have been performed in this work which are described as follows (i) contribution a full study of the chosen features and their effect on the result value with statistical analysis methods, (ii) different ML techniques has been developed and their results are analyzed, (iii) EMT classifier is proposed to forecast the student performance. Results show that the proposed EMT classifier achieved an improved accuracy when compared to the previous classifiers.

Amrieh et al [28] introduced an ANN, NB, DT and Random Forest (RF) for student's performance prediction. The performance prediction model of a new student is suggested based on data mining techniques with new data attributes/features, which are called the behavioural characteristics of the student. The interactivity of the learner with the e-learning

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management system is connected to these types of features. A collection of classifiers, namely ANN, NB and DT, assess the efficiency of the student's predictive model. In addition, to enhance the efficiency of these classifiers, ensemble methods are often applied. The typical ensemble methods used in the literature are Bagging, Boosting and RF. The findings obtained indicate that there is a clear association between the actions of learners and their academic achievement. Compared to the results when eliminating such elements, the accuracy of the proposed model using behavioural features achieved improvement and increased accuracy using ensemble methods. The reliability of the proposed model is proved by this result.

Sweeney et al [29] formulated a Factorization Machines (FM), RF and the Personalized Multi-Linear Regression (PMLR) for student performance prediction. The application of a new technique for selecting features is input to the FM's analytical achievement. Discover strong links between instructor features and student performance by comparing feature significance across populations and across models. Then, important differences between transfer students and non-transfer students are also found. Ultimately, it can be used to accurately predict grades for new and returning students taking both new and existing courses with a hybrid FM-RF method. The implementation of these techniques is promising for the planning of student degrees, interventions by teachers and personalized advice, all of which could improve retention and educational performance.

Kolo et al [30] proposed a DT for student's performance detection in educational. Chi-Square Automatic Interaction Detection (CHAID) based DT structure is introduced by the International Business Machines (IBM) with Statistical Package for Social Studies (SPSS). Parameters such as financial state of the students, capability to learn, gender considered as important and which majorly influence the academic percentage of the students. From the results it concludes that 66.8 % of the students has belongs to pass, rest of them was predicted to fail. A much higher proportion of students are expected to graduate, and male students are even more likely than female students to pass.

Chaffai et al [31] developed a DT and SVM for student performance analysis. Intelligent framework is suggested that can forecast the success in departments chosen by the first year latest register student and suggested the appropriate branch of study. The anticipated framework would help enlightening those who make decision minimize the pace of failure by targeting students who are enrolled new in the department wherever could be able to excel by improving the administration of enrollment. It can be performed based on the ML methods with Hadoop Distributed File System (HDFS) model and the MapReduce (MR) model. To build a prediction model, DT and SVM are used and clustering is used to create a recommendation framework. A genuine case study, with the purpose of the outcomes of students registered in the High School of Technology of Casablanca (ESTC) during 2005 and 2014 is used for simulation. The dataset includes of two broad data sources: the data collection for pre-higher education and the outcome dataset for the primary year of high school studies. The outcomes produced by the method are very proficient during experiments, and the ML methods have been applied be able to be used on a wide range of data sources for future analytics.

Amra and Maghari[32] produced a K-NN and NB classifiers for student performance forecast on secondary school education data set collected by the Ministry of Education in the Gaza Strip for the 2015 year. Since we predict the student success early, the primary intention of such classification can enable the Education of Ministry to get better performance. Teachers should also take the required assessment to enhance learning for students. The

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experimental findings indicate that by obtaining the highest accuracy score, NB is better than KNN.

Adejo and Connolly [33] introduced a DT, ANN and SVM for predicting student academic performance. It relies over three data sources: the record scheme of student, the management of studying method and the assessment, as well as using three classifiers such as DT, ANN and SVM. The findings show that in forecasting student performance and helping to better classify students at risk of attrition, the strategy of using several databases are collectively with assorted ensemble classifiers are extremely successful and perfect. The methodology proposed in this cram would assist administrators of education and policy-makers functioning in the education segment to establish new higher education policies and curricula related to student retention.

Zohair [34] developed a SVM and Learning Discriminant Analysis (LDA) for predicting student's performance. The probability of limited dataset size training and simulation is by the probability for developing a forecasting model along with a consistent accuracy rate. This study also discusses the possibility of using visualization and clustering algorithms to classify the key indicators in the petite dataset that will be used to construct the prediction model. To test them for the most precise model, the best indicators were fed into multiple machine learning algorithms. In the middle of the algorithms chosen, the results demonstrated the capability of the clustering algorithm to classify particular main indicators in small datasets. The key results of this study have shown the efficiency of SVM and LDA training algorithms limited dataset sizes and generating accurateness and consistency test rates for an appropriate classification.

Capao et al [35] proposed a NB for prediction of student's performance. When predicting each student's results, a semi-supervised machine learning method called NB is used. In predicting their results, the researchers identify certain factors to be considered. These variables include the final grades of students taking computer courses in programming subjects, smart quotient, and study patterns, interpersonal and intrapersonal motivation. Training and testing are separated into a data set. The training set helps the computer to learn a prediction model and allows the investigator to assess the accuracy of the test set. The NB correctly projected a student to pass at 76.18 % with the study.

Saheed et al [36] developed an Iterative Dichotomiser 3 (ID3), C4.5 and Classification and Regression tree (CART) for predict student performance. The Waikato Setting for Information Analysis (Weka) experiment was conducted. The experimental results showed the highest precision, specificity, accuracy, recall, f-measure, and incorrectly classified example of ID3. The C4.5 provided the highest accuracy, precision, accuracy, recall, f-measure, and the lowest incorrectly classified case. The results of the CART showed the highest precision, specificity, consistency, recall, f-measure and incorrectly classified instance of 1.70. Experimental findings have shown that C4.5 outperforms other classifiers and takes sufficient time to build the model.

Kaur and Kaur [37] formulated a Classification and Regression Tree (CART) and AdaBoost classifier for predicts students performance. It uses data mining techniques to evaluate and forecast student output for two data sets of 1,000 students, one for mathematics, and the other for system analysis and design. As far as courses of varying complexity are concerned, this research will help the educational community understand student learning behaviour. It is noted that the CART supplemented by AdaBoost is the best classifier for both

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subjects to predict student grades. In addition to AdaBoost, J48 performs well for machine analysis and design, but performs worse for mathematics, and M5P provides the best results in the main test for early prediction of student marks.

Aydoğdu [38] formulated an ANN on behalf of predicting students' performance.ANN, performance forecasts are usually made based on student ratings, but bringing into play of the system of learning management by learners are non-oriented. In this report, ANN tried to predict the performance of 3518 university students who are studying and by actively participating in a learning management system. Proposed ANN makes a prediction with an improved accuracy as a result of the study. At last, it was found with the purpose of the attributes of the amount of live class student's presence, the amount of archived class attendance, and the time spent on the content produced much of the forecast of the results variable. On the other hand, since there is typically limited data volume in educational datasets, the ML methods were primarily a shallow learning method. There is also space for growth in prediction accuracy in general. The aim of this part is to predict future performance for a given course depending on student backgrounds and history performance. For the success prediction of students, which was concentrated in the following portion via Deep Learning (DL) methods such as Deep Neural Network (DNN), Bidirectional Long Short Term Memory (BLSTM) and Recurrent Neural Network (RNN) was used.

3. DEEP LEARNING METHODS FOR STUDENT PERFORMANCE PREDICTION

In order to promote timely educational interventions within a course, topic and degree, accurate early stage forecasts of the potential success of a student may be crucial. Thus, from a deep learning perspective, very few previous studies have explored this issue. This segment discusses the specifics of the DL techniques that are used to predict student results.

A Deep Neural Network (DNN) for predicting student success was introduced by Guo et al[39] which automatically learns numerous levels of representation. Unattended learning with sparse auto-encoder is introduced for unlabeled data, pre-train hidden layers of features are intelligently, and subsequently supervised training is proposed to modify the parameters. In addition, the training model on the data set of a comparatively huge real world student, and the implementation results shows that the feasibility of the proposed approach that be able to be introduced to the academic pre-warning method.

Waheed et al [40] developed a Deep Artificial Neural Network (DANN) to predict academic performance of students. It is on a collection of specific handcrafted features, derived from the click stream data of virtual learning environments, to predict that at-risk students have early intervention measures for such cases. In order to achieve the highest accuracy in classification, the results display the future model. It also indicates that the baseline LR and SVM are exceeded by a deep ANN. Aligned with current research, the results indicate that the use of legacy data and evaluation-related data has a substantial effect on the model. To demonstrate better results, students interested in accessing the material of the previous lectures are observed. The study aims to help institutions establish the necessary structure for pedagogical support, fostering the decision-making process for higher education towards sustainable education.

Kim et al [41] proposed a deep learning supported algorithm, termed GritNet, which constructs over the Bidirectional Long Short Term Memory (BLSTM) for student performance prediction. The GritNet's two new characteristics are that (1) they do not require

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any function engineering (it can learn from raw input) and (2) it can run (even if highly imbalanced) on every scholar event data associated with a time stamp. Proposed results from the real graduation predictions of Udacity students show that the GritNet not only consistently exceeds the standard LR-based process, but to facilitate changes in the primary not many weeks are significantly pronounced whilst accurate predictions are the majority difficult.

Huang et al [42] formulated an Exercise-Enhanced Recurrent Neural Network (EERNN) and Exercise-aware Knowledge Tracing (EKT) for student performance prediction. EERNN structure is proposed by exploring the practice records of both students and the text content of the corresponding lessons, where the state of each student is clearly summarized into an integrated vector. Develop pair of implementations on the foundation of EERNN with dissimilar approaches to make final predictions, i.e. EERNNM with Markov possessions and EERNNA among Attention method. After that, specifically track the acquisition of student knowledge on multiple knowledge concepts, extend EERNN to an explanatory EKT system by integrating knowledge concept in order, wherever the position vector of the student is extended to a matrix of the acquaintance condition. The results of the experiments on large-scale data show the usefulness of the two systems and the interpretability of EKT.

Okubo et al [43] introduced a Recurrent Neural Network (RNN) for student's performance forecast. Log data contained in the system of education for estimation of final grades of students by an RNN. The log statistics reflected the learning performance of students who used the method of learning administration, the scheme of e-portfolio and the system of e-books. The RNN broadcasts the prior time domestic mined data at the present occasion and acquire the yield value on the basis of the existing time information and the past information. Therefore, in view of the previous condition, it is possible to make. This methodology was also applied to the log data of 108 students and tested the accuracy of forecasting. It is verified from the experimental results that an RNN is successful for early on prediction of concluding rank as compared with multiple regression analysis.

Karimi et al [44] introduced a Deep Online Performance Evaluation (DOPE) in RNN classifier. DOPE, which first models student course relationships as an information graph in an online environment, then uses an advanced graph neural network to extract course and student embedding, uses an RNN to encode the temporal student behavioural data of the system, and finally predicts the performance of a student in a given course. Comprehensive studies on six online courses check the efficacy of DOPE against representative baseline approaches across different environments. In addition, to better understand the inner workings of DOPE, conduct ablation function analysis on the student behavioural characteristics.

Tsiakmaki et al [45] introduced a new DNN based transfer learning for the task of students' performance prediction in higher education. Because it has be inadequately studied so far to predictive models are developed in the field of EDM via transfer learning algorithms, this research is considered a major step in this direction. An excess of studies were so carried out depending on data from five necessary courses in two undergraduate programmers. Experimental results indicate with the purpose of in most cases, the prognosis of students at risk of failure be able to be achieved by means of suitable accuracy, given with the purpose of databases are accessible for students who have taken previous related courses.

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Sultana et al [46] proposed a DNN, RF, DT and NB for student's performance prediction. A DNN, RF, DT and NB for student success prediction was proposed by Sultana et al[46]. EDM is a methodology or a mechanism used by a large educational database to mine useful knowledge and trends or types. Subsequently, the output of the student is estimated from the useful knowledge and trends obtained. The primary motto of this study is to use certain classification strategies to discover the success of students and to find the right one that produces optimum results. A Saudi University database gathers the Educational Dataset. To philtre duplicate information, the dataset is pre-processed; missing fields are found and filled with the destined data. Using Weka and Rapid Miner instruments, DL techniques are used on the dataset. On a few metrics, the outcomes obtained are evaluated. Compared to other methods, DNN and DT excel in predicting the success of students by making deep predictions and achieving the best outcomes, such as high precision, kappa-statistic, Sensitivity and Specificity are also determined.

Li et al [47] introduced a Sequential Prediction based on Deep Network (SPDN) and for student academic performance prediction. These pair of data sets from 505 university students are used, i.e., online education report on behalf of a project-based classes and university campus network logs. A system for deep learning: SPDN to predict the success of students in the course. SPDN models the online behavioral sequences of students using the Convolutional Neural Network (CNN) multi-source fusion technique and integrates LSTM-based static knowledge. Experiments show that the anticipated SPDN model performs its baselines by increasing early warning significantly. In addition, that could be educated that patterns of accessing the Internet even having a better effect taking place the performance in education of students than learning practices in online.

Zacharis [48] developed an ANN and Multi-Layer Perceptron Neural Network (MLPNN) for predicting student academic performance. This educational artificial intelligence enables teachers to analyze data collected from university servers, recognize student behaviour trends, and create solutions for students who are struggling. Based on data obtained from the online activities of students in web-based blended education courses are the efficiency of ANN in predicting student achievement. Based on four learning activities, this study utilized scholars data accumulated on a Moodle server and forecasted learner's progress in the course: communication through emails, collaborative content development with wiki, database engagement assessed by viewed files and self-evaluation via online interrogation. Next, the MLPNN-based representation was skilled to envisage the excellence in academic of students in a mixed learning atmosphere. The model projected an improvement in the output of students with the correct level of classification.

Su et al [49] formulated an EERNN intended for learner's performance prediction by enchanting full benefit of student exercising records and the text of each exercise together. Specifically, first build a bidirectional Long Short Term Memory (LSTM) to learn each exercise representation from its text definition without any experience and loss of knowledge to model the student exercise method. A new LSTM architecture is then proposed to trace student states (i.e. , information states) along combination of exercise depiction in their sequential exercise phase. Two strategies under EERNN, i.e., EERNNM with Markov property and EERNNA with Attention mechanism are developed to make final predictions. The efficiency of the EERNN system is clearly demonstrated by comprehensive studies on significant, practical life results. In addition, EERNN will deal well with the cold start issues from both student and exercise viewpoints by combining the exercise similarities.

Kuo et al [50] developed a DNN and K-Means for student performance prediction. Student data and course outcomes from recent years have been used as training data to create

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models for student performance prediction. For classifying all courses from freshman to senior, the K-Means algorithm was used. The associated courses have been grouped into the same cluster, which is more likely to recognize similar characteristics and increase the accuracy of the forecast. This research then built individual neural networks according to the different academic year for each course. Using the Auto-encoder denoising, each model was pre-trained. The corresponding structure and weights were taken as the initial value of the neural network prediction model after the pre-training stage. As a base predictor, every neural network is viewed. In order to predict the current student's course results, all predictors were merged into an ensemble predictor according to different years' weights. The prediction model will continue monitoring and updating as students complete the course at the end of each semester.

Babulal and Agrawal [51] proposed a DNN and SVM for student performance prediction system. Using the notion of data mining with a machine learning approach, the precision rate of the student performance prediction system is built. The primary step of this study is to collect data from the database by using the principle of Cosine similarity with the K-mean clustering approach to clean unstructured data in stricture form. After that, the clustered data is used to train the DNN, and the result is also cross-validated using the SVM approach. The performance parameters are, eventually, calculated. The findings show that with the DNN method, the SVM performs well and provides better prediction accuracy to assess student results.

Transfer learning is an approach to machine learning that aims to use the knowledge obtained from one problem to boost a learning model's predictive output for a different but related problem. This is mostly the case when there is a need of information regarding a problem, however there is a lot of information regarding another issue which is parallel. To this end, the current learning aims toward study the efficiency of transfer learning from DNNs designed for the students' task of predicting advanced education performance. Because the improvement of predictive methods in the field of Educational Data Mining (EDM) has consequently far been inadequately studied during transfer learning methods, we regard as this study to be an significant step in this way.

4. DATA MINING METHODS FOR STUDENT ACADEMIC PERFORMANCE PREDICTION

Forecasting academic performance is a significant task for the students in university, college, and school, etc. Thus this section majorly reviews the details of performance prediction methods in academics.

Fernandes et al [5] presented a predictive analysis for student academic performance in public schools of Brazil. Descriptive statistical analysis is introduced towards gain close by from school terms beginning federal districts of Brazil for the duration of the 2015 and 2016. From this two datasets were created. The initial dataset includes attributes attained prior towards the beginning of the school year, and the second incorporated academic attributes together two months following the semester start. Gradient Boosting Machine (GBM) is introduced for academic performance prediction of student at the end of the school year for each dataset. Results showed with attributes like ‘grades' and ‘absences' were the mainly suitable for predicting the end of the year academic grades of student performance, the learning of demographic attributes reveals with the purpose of ‘neighborhood’, ‘school’ and ‘age’ are also feasible indicators of a student's academic success or not a success.

Miguéis et al [7] introduced a two-stage model with the purpose of making use of the data obtainable at the end of the first year of students' academic work towards predicting their

entire educational results. European Engineering School with 2459 students for the duration of 2003 to 2015 is used to assess this model. Results show that this model attains 95% of accuracy, in an early stage of the students' educational path. Among them many classifiers such as DTs, SVMs, NBs, bagged trees and boosted trees and Random Forests (RFs), RF gives higher results. This model describes a supportive tool towards explaining the optimum algorithms to apply, in order to progress improved results levels and lessen educational failure, mostly getting better the value of the educational knowledge offered by means of an advanced education organization.

Martins et al [16] introduced towards provide the organization by means of single particular tool able to include the heterogeneity of the universe of students in adding together towards educational dynamics. In this work, a regression model is introduced for early on stage of academic performance prediction and which is worked depending on the RF classifier in IPB undergraduates at the boundary of their academic course. It has been used at a middle level by the decision-makers who are unrestricted towards aspire actions towards fair academic failure.

Zaldivar-Colado et al [52] proposed an ANN system for student performance prediction of 3518 university students in a learning management scheme. It is challenging to take how much input attributes in ANNs system towards predicting output attributes, these networks are named black boxes. It shows the accuracy results of 80.47% in a learning management system. Finally, it was confirmed with the purpose of the attributes of total of presence towards the exits classes, the total of attendance in the direction of archived courses and the time exhausted in the content specified essentially to the prediction of the output feature.

Asif et al [53] introduced a contextual analysis on foreseeing performance of students toward the finish of a college degree at a beginning phase of the degree program, so as to help colleges not exclusively to zero in additional on brilliant students yet in addition to at first distinguish students with low scholarly accomplishment and discover approaches to help them. The information of four scholastic associates involving 347 college students has been mined with various classifiers. The outcomes show with the purpose of it is conceivable to anticipate the graduation results in fourth year at college utilizing just pre-college marks and characteristics of first and second year courses, no financial or demographic attributes, with a sensible precision. Besides courses that are markers of especially great performance has been distinguished.

Mueen et al [54] proposed classifiers such as NBs, NN, and DT for prediction performance in two undergraduate courses dataset. From the results it is found that the NBs classifier works better than the other two classifiers with the accuracy of 86%. It assists teachers to increase student academic performance. Mesarić and Šebalj [55] introduced a new classifier which correctly categories students into either pass or fail class based on their achievement at the end of their first academic year, and discovering meaningful attributes concerning their success. Numerous classifiers for creating DTs were compared and the numerical significance (t-test) results were examined. From the Regression Tree representative (REPTree) DT algorithm highest accuracy of 79% was achieved, but it fails to classify two classes accurately. This issue is solved by applying the J48 algorithm. The largely important attributes were full points in the state exam, points from high school and points in the Croatian verbal communication exam.

Oshodi et al [56] proposed a Logistic regression and SVM for academic student performance prediction depending on data enclosed in previous academic achievement. The

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initial part was used for training the classifier, at the same time as the other part was used to assess the accuracy of the proposed classifiers. It focuses on the result of previous academic success on academic results of architecture students. Xu et al [57] proposed classifiers such as DT, NN and SVM towards expose the association among Internet usage behaviors and educational performance, and towards forecast undergraduate's educational performance from the standard data. The results show the behavior regulation plays a necessary part in educational success. Internet connection occurrence features are totally related by means of learning performance, at the same time as Internet traffic volume features are negatively related by means of learning performance. From the viewpoint of the online time features, Internet time inspired results in unexpected performance with different datasets. Furthermore, as the total of features increase, accuracy is frequently improved in the classifiers. The results show the purpose of Internet usage data is to differentiate and predict a student's learning performance.

Burman and Som [58] introduced a multi SVM classifier to categorize the learners into high, average and low based on their educational scores. It is performed based on the SVM with linear kernel and Radial Basis Function (RBF) Kernel. The SVM with RBF gives better results than the linear kernel. Predicting the performance of students in advance will be able to benefit the institution and learner to obtain considerable steps in order to improve the learning procedure.

Bhutto et al [59] proposed a students' educational performance prediction algorithm which makes use of supervised category of ML classifiers such as SVM and LR. The results supported by a variety of experiments using diverse methods are assessed and it is shown with the purpose of a sequential minimal optimization algorithm that gives improved results when compared to LR. And the information established throughout this research is able to assist educational institutes towards forecasting the future behavior of students so with the purpose of they are able to classify their results into superior or bad. The aim is not just towards forecast future performance of students other than also give the greatest technique for discovering the mainly impactful attributes to effort on like teacher's performance, student's inspiration with the purpose of will finally decrease the student's failure ratio. Hamoud et al [60] presented DT algorithms such as J48, Random Tree(RT) and REPTree with the questionnaires filled in by students. Totally it includes 161 questionnaires and these classifiers are implemented via the Weka 3.8 tool. Results it concludes that the J48 algorithm provided better results than the RT and REPTree.

5. RESEARCH GAPS FROM REVIEW WORK

The requirement to predicting student academic success has become a vital factor in enhancing the quality of academic course; assisting students when learning and offering more opportunities to tutors while teaching their students. Recently, several works related to this topic have been published. Numerous reviews were established examining the form of student academic achievement in a variety of views. Though, predicting student success in an academic is not a one-time task; rather, as the student finishes fresh subjects over time, it needs constant monitoring and updating. In this regard, an important consideration is with the purpose of the forecast must be depends not only on the generally recent picture of student achievements, however also on the development of student growth, which be able to contain helpful information towards formulate more accurate predictions. The complexity can easily erupt, because it can be a challenging task to even mathematically reflect the progression of student development itself. However, it may not be a good decision to treat the past success

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equally as the present results when forecasting the future either as intuition teaches us that old knowledge appears to be outdated.

6. SOLUTION

Waheed et al [40] proposed a DL classifier with an increase of accuracy of 4.3% when compared to SVM with conventional kernel function. A DL method is combined to SVM classifier for student performance prediction [40]. Some of the works have been discussed as follows.

Francis and Babu [61] developed a new method for assessing student's performance in academics depending on classification and clustering methods. These methods have been experimented on a real time student dataset for Kerala state with several educational disciplines. It has experimented using the classifiers such as SVM, NB, DT and NN. Classifiers are implemented to K-means clustering by means of majority voting. Results are evaluated using the measures such as precision, recall, f-score and accuracy.

Tsiakmaki et al [62] developed to examine the efficiency of transfer learning from DNNs for students' performance forecast in superior education. For the reason that building predictive methods in the EDM area via transfer learning algorithms has been imperfectly studied consequently far, this study is regarded as a significant step in this way. Thus, an excess of experiments were performing depending on information originating from five essential courses of two undergraduate programs. Results show with the purpose of the prediction of students at risk of failure is able to be attained by suitable accuracy in general cases, presented with the purpose of datasets of students who have attended previous associated courses is accessible.

Wang et al [63] introduced an attention-based Hybrid Recurrent Neural Network (HRNN) for knowing their present behaviors by means of open-handed an advanced weight towards the ones with the purpose of being connected towards the students' last success. After that, student performance prediction is performed, additional involve these learned features towards the standard SVM classifier and finally complete Sequence-based Performance Classifier (SPC) model. Several experiments of real-world student card dataset; it shows with the purpose of the improved results are achieved by proposed method via Recall and Accuracy.

Improved Conditional Generative Adversarial Network based Deep Support Vector Machine (ICGAN-DSVM) algorithm is proposed by Chui et al [64] for student performance prediction. It aims at handling the issue of low data level by replicating new training dataset, DSVM is extended from SVM classifier by means of shallow learning to DL. DSVM is applied to small dataset and results are compared to conventional DNN. Vora et al [65] developed DL classifiers for classification and prediction in educational data. The dataset is collected from students in the engineering domain by means of cognitive and non-cognitive parameters. The hybrid algorithm by means of SVM and Deep Belief Network (DBN) is developed. The SVM predicts class labels from preprocessed data. It is given as input to the DBN to perform classification and prediction. The hybrid algorithm is further tuned via Levy flight with Cuckoo Search (LC). A result shows with the purpose of the proposed SVM-LCDBN algorithm gives increased results when compared to usual hybrid model and hybrid model with usual Cuckoo Search (CS).

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7. INTERPERTATION AND EVALUATION

In this section measure the results of deep leaning and machine learning methods via the dataset collected from https://archive.ics.uci.edu/ml/datasets/student+performance. Dataset includes of student success in secondary education of two Portuguese schools. The data features consist of student grades, demographic, social and school related features and it was collected with school reports and questionnaires. Two datasets are presented regarding the performance in two individual subjects: Mathematics (mat) and Portuguese language (por). The target attribute G3 has a well-built correlation by means of attributes G2 and G1. This occurs since G3 is the final year grade (concerned at the 3^{rd} period), while G1 and G2 correspond to the 1^{st} and 2^{nd} period grades. It is further hard to predict G3 without G2 and G1, but such forecast is much more helpful [66]. The results are compared via the methods like ICGAN-DSVM, ICGAN, CGAN, Naïve-Bayes(NB), Decision Tree(DT), Artificial Neural Network (ANN), and Support Vector Machine (SVM). Table 1 summarizes the specificity, sensitivity and AUC of classifiers. Specificity and sensitivity are defined as follows.

$$\text{Specificity} = TN/N_n \quad (1)$$

$$Sensitivity = TP/N_p \quad (2)$$

where TN is true negative, N_n is number of negative samples, TP is true positive and N_p is number of positive samples.AUC is the area under the 1- specificity and Sensitivity curve.

Table 1: - Performance of comparison of classifiers with respect to Specificity, Sensitivity and AUC

Methods	Specificity (%)	Sensitivity (%)	AUC (%)
NB	85.23	84.93	83.77
DT	86.42	85.17	85.65
ANN	87.55	87.92	87.82
SVM	88.36	89.13	88.48
CGAN	89.71	89.44	89.75
ICGAN	90.82	90.45	91.16
ICGAN-DSVM	91.46	91.76	91.97

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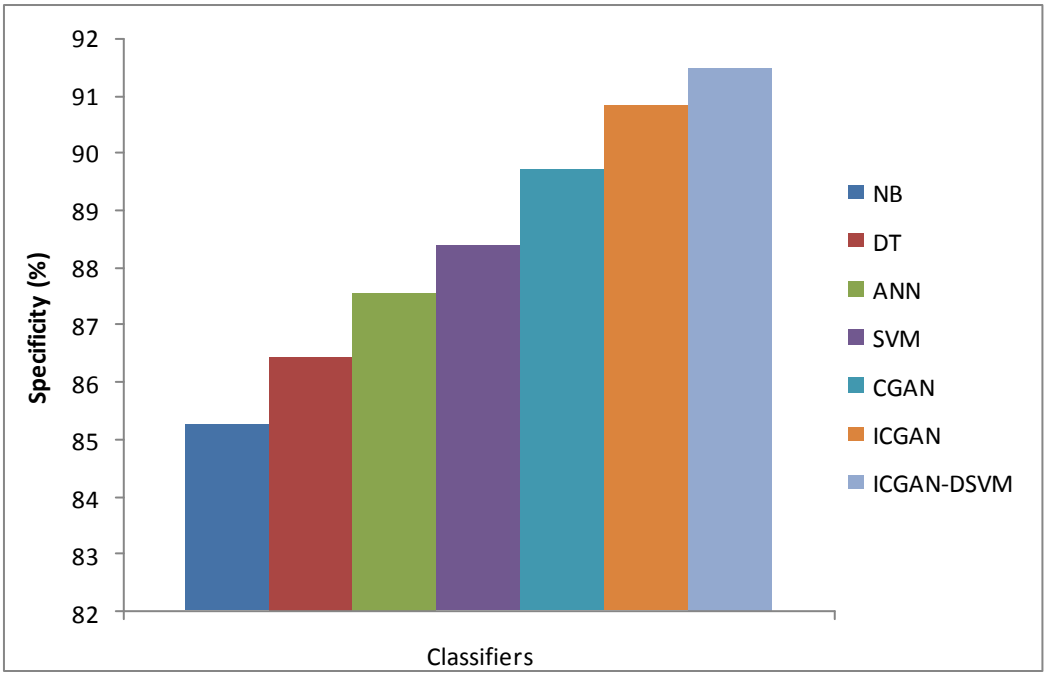

Figure 2: - Performance Comparison between Approaches for Specificity

Figure 2 shows the performance comparison of various classifiers with respect to specificity. The proposed ICGAN-DSVM classifier gives highest specificity results of 91.46%, whereas other classifiers such as NB, DT, ANN, SVM, CGAN and ICGAN gives the specificity results of 85.23%, 86.42%, 87.55%, 88.36%, 89.71% and 90.82% respectively.

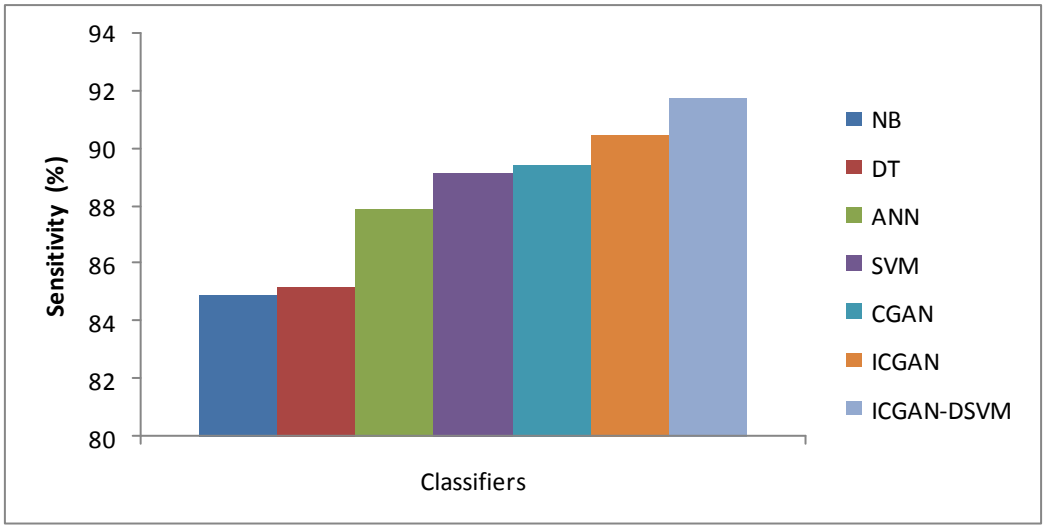

Figure 3: - Performance Comparison between Approaches for Sensitivity

Figure 3 shows the performance comparison of various classifiers with respect to sensitivity. The proposed ICGAN-DSVM classifier gives highest sensitivity results of 91.76%, whereas other classifiers such as NB, DT, ANN, SVM, CGAN and ICGAN gives the sensitivity results of 84.93%, 85.17%, 87.92%, 89.13%, 89.44% and 90.45% respectively.

ISSN: 2233-7857 IJFGCN

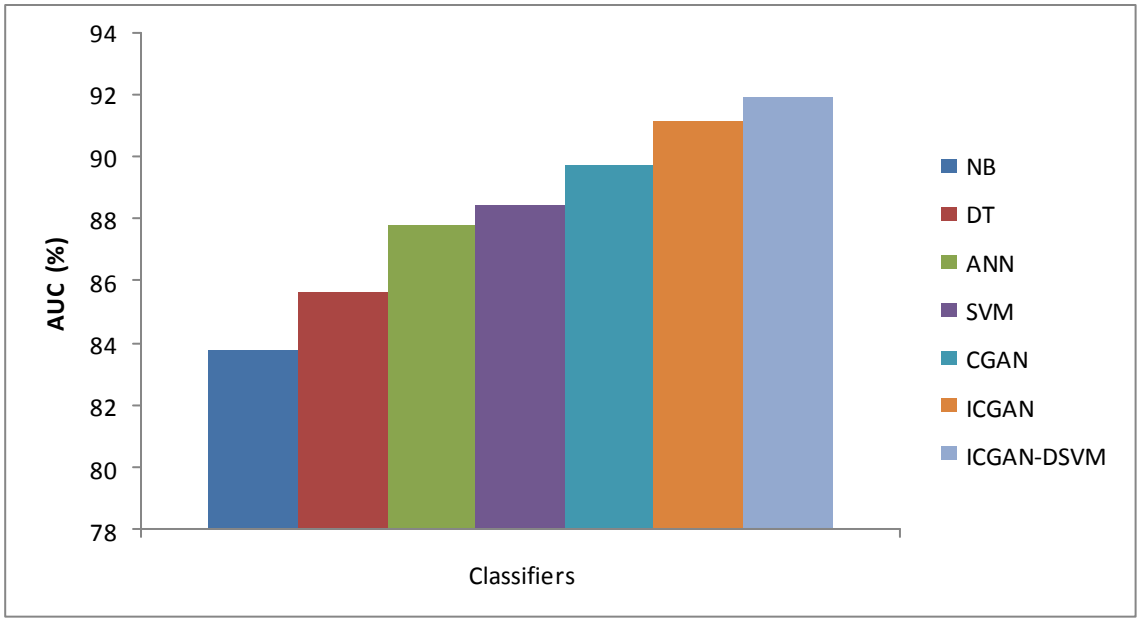

Figure 4: - Performance Comparison between Approaches for AUC

Figure 4 shows the performance comparison of various classifiers with respect to AUC. The proposed ICGAN-DSVM classifier gives highest AUC results of 91.97%, whereas other classifiers such as NB, DT, ANN, SVM, CGAN and ICGAN gives the AUC of 83.77%, 85.65%, 87.82%, 88.48%, 89.75% and 91.97% respectively.

8. CONCLUSION AND FUTURE WORK

Student performance prediction is very useful in the current educational framework. It will assist students and their instructor to monitor the student's performance. Today, many organisations have implemented a continuous assessment method that is carried out manually. In improving a student's efficiency, such systems are advantageous for students. Machine Learning (ML) and Deep Learning (DL) techniques are common in data mining applications and have many popular implementations in a wide variety of applications. This review analysis is used to forecast the success of students on the specifics of DL and ML methods. To build prediction algorithms, several ML methods have been applied. It is not clear, however, that the performance of students is accurately predicted among the different ML models, as different authors have provided conflicting findings regarding the prediction accuracy of the models. The majority of ML models focused primarily on forecasting the performance of students without considering mechanisms to increase student learning experience. Therefore, the use of DL methods in predicting the success of students has demonstrated to be helpful in recognising the best performers and can enable tutors to take remedial steps at an earlier level, even from the very beginning of an academic year, using only the internal evaluation data of students from previous semesters to provide additional assistance to at-risk classes. Furthermore, the result of ML is improved by integrating DL techniques to predict the performance of students. This shows that, in addition to taking into account the positive outcomes, there are many open opportunities for the use of DL in EDM field. In this research, a detailed study of DL techniques was also given, beginning with a beginning towards the area, an overview of the categories of DL methods used in EDM, and a list of current frameworks to assist in EDM development. The data reviewed in this research will provide as an origin for the initiation of potential improvement in EDM area with hybrid

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DL methods. Future work involves expanding the output prediction to students by hybrid DL techniques and using the effects of the prediction to suggest interested subjects to students. It offers a starting point for research in the fields of hybrid DL for EDM in order to exploit the potential of these approaches in the educational field.

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ISSN: 2233-7857 IJFGCN